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EXAMINER	
RUGGLES, JOHN S	
ART UNIT	PAPER NUMBER
1756	3

DATE MAILED: 06/27/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

mx-3

Office Action Summary	Application No.	Applicant(s)	
	10/050,417	PHAN ET AL.	
	Examiner	Art Unit	
	John Ruggles	1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 April 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20,22 and 23* is/are rejected.

7)☒ Claim(s) *6,8,12,14,18 and 21* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a)☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1)☒ Notice of References Cited (PTO-892)
2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3)☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *2* .
4)☐ Interview Summary (PTO-413) Paper No(s). _____ .
5)☐ Notice of Informal Patent Application (PTO-152)
6)☐ Other: .

DETAILED ACTION

Drawings

Figures 1-2 and 5A-5B should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

The drawings are objected to because the text in block 246 of Figure 6B does not match the description thereof found at lines 19-20 on page 13 of the specification. The examiner suggests changing "I.E., 2,500 RPM" in block 246 of Figure 6B to --e.g., 4500 RPM--, in order to match the description. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Specification

The disclosure is objected to because of the following informalities: (1) at line 6 on page 6, "process" should be changed to --processed--, to be grammatically correct; (2) at lines 16-17, also on page 6, applicant is requested to clarify whether "DI" water really refers to "develop inspection" water as stated or actually refers to --deionized-- water as found elsewhere in the specification (e.g., for rinsing at lines 6-7 on page 14, etc.) as is more commonly intended by this abbreviation, in fact, the phrase "develop inspection" appears elsewhere in the specification but is not accompanied by this abbreviation (e.g., at line 12 on page 15, etc.); and (3) at line 2 on page 11 and line 21 on page 14, applicant is also requested to clarify whether "post exposure

bake" is actually represented by "PBE" as stated (which could be confused with the very different phrase, "post bake exposure") or would better be represented by the abbreviation --PEB--, as is more commonly used and better represents this phrase.

Appropriate correction is required.

Claim Objections

Claims 8, 12, 14, and 18 are objected to because of the following informalities: in claims 8, 12, 14, and 18, "at speed" should be changed to --at a speed--, to be grammatically correct. Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 2-12, 17-19, and 22 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 2 and 22 are rendered indefinite by the phrase "type". See MPEP § 2173.05(b), part E "Type". Also in claims 2 and 22, "HMDS" has not been defined nor the component(s) thereof specified in the instant specification. For the purpose of this Office action and to advance prosecution of this application, this abbreviation has been interpreted to mean --hexamethyldisilizane--, which is commonly abbreviated --HMDS-- in this art. However, claims

2 and 22 must still be amended in response to this rejection. Claims 3-12 are dependent on claim 2.

In claims 3 and 19, it is unclear what is meant by "performed at a low range of temperatures" for the special vapor prime operation. This phrase implies plural steps at different temperatures, but this has not been supported by the specification. Note that while dependent claims 4, 20, and 22 further limit the low temperature for the special vapor prime operation to be in the range of about 85 degrees C to about 130 degrees C, none of these claims require plural steps at different temperatures. In fact, claim 22 requires that priming be done at "a temperature" within this same temperature range. Therefore, for the purpose of this Office action and to advance prosecution of this application, this phrase has been interpreted to mean --performed at a low temperature--. However, claims 3 and 19 must still be amended in response to this rejection. Claims 4-12 are dependent on claim 3.

In claims 11 and 17, it is unclear whether the phrase "at a speed of about 4500 RPM with a low acceleration of about 1000 RPM per second" means that the rotation is carried out (1) starting at 4500 RPM and increasing at 1000 RPM per second, (2) increasing at 1000 RPM from a previous speed (not specified in this claim) up to a maximum of 4500 RPM, or (3) some other variation not specified, such as averaging 4500 RPM with a maximum increase in speed of 1000 RPM per second. Claim 12 is dependent on claim 11 and claim 18 is dependent on claim 17.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-3 and 19 are rejected under 35 U.S.C. 102(b) as being anticipated by Palmer (US Patent 4,768,291).

Palmer teaches a method and apparatus for processing a semiconductor wafer. The process reduces defect density (especially those resulting from unwanted residue) and promoting adhesion of photoresist by baking and liquid or vapor hexamethyldisilizane (HMDS) priming a semiconductor substrate before coating with photoresist (column 1, lines 32-38). After imagewise exposure of the photoresist and developing to remove the exposed portion of the photoresist, additional silylation of the imaged photoresist by HMDS at a vapor pressure of 6-500 Torr enhances resistance to plasma etching (column 3, lines 18-44). Removal of the exposed photoresist is understood to include resist residues, since Palmer points out the necessity of particular handling techniques to ensure that no residue of processing liquid be left on the wafer in wet processing steps at column 2, lines 53-56 (instant claims 1-2). The HMDS priming is carried out at any one of various pressures (e.g., 6 Torr, 200 Torr, etc.). The vapor pressure of HMDS varies with temperature as shown in Figure 4. An HMDS vapor pressure of 200 Torr corresponds to a temperature of more than 70°C (roughly 85°C) and that of 500 Torr roughly corresponds to 130°C (column 4, lines 1-10, instant claim 4 for about 85°C to about 130°C). At column 4, lines 2-5, Palmer states there is evidence that the priming process would be carried out faster and perhaps more effectively at a higher pressure (higher concentration of HMDS). This indicates that the HMDS vapor priming could be performed at a low temperature in a relatively short time (instant claims 3 and 19).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 4, 20, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Palmer in view of Peterson, et al. (US Patent 5,429,673).

While teaching HMDS vapor priming at a temperature in a range that fully encompasses about 85°C to about 130°C and even indicating that it would be advantageous to perform the priming in a relatively short time, Palmer does not specify the relatively short time to be about 5 seconds to about 20 seconds.

Peterson shows silylation by HMDS vapor priming the surface of a semiconductor substrate at a temperature of about 25°C to about 200°C (column 6, lines 1-11) and gives examples of HMDS vapor priming at the following specific temperatures and times: (Example 2) 50°C for 20, 40, and 60 seconds; (Example 3) 60°C for 30 seconds; and (Example 4) 100°C for 10 seconds (column 7, lines 18-60). HMDS vapor priming of a semiconductor wafer improves adhesion of subsequently applied photoresist and can repel polar groups such as water and aqueous developers (column 1, lines 46-65)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined the HMDS vapor priming at about 85°C to about 130°C for a

relatively short time as taught by Palmer with the relatively short time for this HMDS vapor priming of about 10 seconds (for 100°C) to about 60 seconds (for 50°C). This is because both references teach the same type of treatment (HMDS vapor priming of a semiconductor substrate) for the same and/or similar reason (to improve adhesion of photoresist and/or repel unwanted residue). Furthermore, extrapolating this time trend shown by the Peterson examples for the HMDS treatment within the temperature range shown by Palmer to about 130°C would be expected to reduce the needed treatment time to less than 10 seconds (e.g., to about 5 seconds, etc.).

Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Palmer in view of Peterson and further in view of Erhardt, et al. ("*An Investigation of Circular Resist Residue Defects in the Development of a 0.16μm Flash Process*", cited as prior art in applicant's IDS of Paper #2, filed 04 April 2002).

Palmer and Peterson do not specifically teach maintaining a high exhaust air velocity during spin developing.

Erhardt describes techniques for reducing resist residue defects in semiconductor device manufacture. In reference to Figure 7 on page 4 of 6, reduction in developing spin speed minimizes the amount of splashing inside the developer cup and consequently reduces formation of developer droplets containing resist residue. Also shown in Figure 7, increasing cup exhaust reduces the amount of resist byproducts carried by these droplets surrounding the wafer (found in the second full paragraph in the first column on page 5 of 6). This is understood to mean that a high exhaust air velocity during developing would reduce defects by carrying the resist residue

droplets away from the spinning wafer before they could redeposit on the wafer. It is also suggested that resist residue can be minimized by extending rinsing cycle(s) after developing (second full paragraph in the first column on page 4 of 6). The overall photolithography process can be fine-tuned to minimize defects through a combination of reduced generation and enhanced removal (third full paragraph in the first column on page 5 of 6).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the process as taught by Palmer and Peterson by increasing cup exhaust air velocity to a high rate during developing to carry away developer droplets containing resist residue and prevent their redeposition on the semiconductor wafer, with the expectation of reducing resist residue defects as described by Erhardt.

Claims 7-18 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Palmer in view of Peterson, further in view of Erhardt, further in view of Ebersole (US Patent 5,324,620), and further in view of Orth (US Patent 5,750,317).

Palmer, Peterson, and Erhardt do not teach rinsing front and back sides of the resist coated semiconductor substrate in separate steps while spinning at a medium and a low speed, followed by further washing of the front side before drying while spinning at a high speed.

Ebersole discloses a radiation sensitive composition (resist) and a method of using this resist for making circuits by coating the resist on a semiconductor wafer, imaging, and developing the resist to form a desired pattern. The developing was carried out in a spray developing spinner by (1) dispensing the developer for 3 seconds while spinning the substrate at 500 RPM, (2) holding for 60 seconds, (3) rinsing for 20 seconds with deionized water at 1,000

RPM, and (4) drying for 10 seconds at 5,000 RPM (column 23, lines 32-36). The medium speed rinsing is understood to include removing both developer and resist residues from both front and back sides of the wafer before drying by spinning at high speed. Increasing the spinning speed necessarily involves acceleration, but the rate of this acceleration is not specified.

Orth teaches a process of removing undesired resist residue (e.g., edge beads, etc.) which cause defects on a semiconductor wafer by solvent washing while spinning the wafer. This preferably includes dispensing the solvent at the back of the wafer, allowing centrifugal force to spread the solvent to the edge of the wafer (column 6, lines 7-11). The solvent is dispensed for approximately 10 seconds while spinning the wafer at a low speed of approximately 250-500 RPM (column 6, lines 54-55). This is followed by further dispensing of solvent while ramping up the speed over a 5 second interval to a high speed of 3,000 RPM or higher (up to at least approximately 4,000 RPM or higher, column 6, lines 23-27 and 50-52). This represents an average acceleration of about 500-950 RPM per second, which reads on a low acceleration of about 1,000 RPM per second for a top high speed of about 3,000-5,000 RPM (instant claims 11 and 17). The wafer is spun at the high speed for an additional 15 seconds and then dried at 1,500 RPM (column 6, lines 33-41).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the process as taught by Palmer, Peterson, and Erhardt to incorporate medium speed rinsing and low speed rinsing as disclosed by Ebersole and taught by Orth as well as high speed drying as disclosed by Ebersole and taught by Orth This is because all these references relate to the same art of removing resist residue from semiconductor substrates. In fact, Erhardt specifically states the advantages of using lower developer spinning speed to reduce

splashing (reduced generation of residues) and increasing the number and/or length of rinsing cycle(s) after developing (enhanced removal of residues) in order to reduce resist residue defects. This is understood to include plural separate medium and low spinning speed rinsing steps of both front and back of the spinning substrate, with the expectation that reducing the spinning speed during the second or subsequent rinsing will create less splashing and generate less resist residues which cause defects. Once the residues are removed by this sequence of rinsing steps, splashing during drying is not likely to result in any defects. Therefore, high speed spinning during drying would be expected to reduce overall processing time without generating additional resist residue defects (instant claims 7, 13 and 23). Likewise, it would also have been obvious to have doubled (from 20 to 40 seconds) the length of the medium speed 1,000 RPM rinsing step of Ebersole based on the suggestion of Erhardt that increasing the length of rinsing cycle(s) would enhance removal of resist residues (instant claims 8 and 14). During fine tuning of the rinsing process as described by Erhardt, the low speed solvent rinsing step at approximately 500 RPM for approximately 10 seconds of Orth approaches and reads on the low speed rinsing at about 600 RPM for about 8 seconds of instant claims 9 and 15. Additionally, the 5-second interval of solvent dispensing as taught by Orth during ramping up the spinning speed is substantially equivalent to the instant third time period for rinsing of about 5 seconds (instant claims 10, 12, 16 and 18).

Allowable Subject Matter

Claims 6 and 21 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: while the concept of using a high exhaust air velocity during spin developing of an imaged resist on a semiconductor substrate is not new (for the reasons discussed above), the specific exhaust air velocity range of about 5 meters per second to about 6 meters per second of instant claims 6 and 21 are distinguished over the prior art, which does not teach this specific range for exhaust air velocity during spin developing.

As allowable subject matter has been indicated, applicant's reply must either comply with all formal requirements or specifically traverse each requirement not complied with. See 37 CFR 1.111(b) and MPEP § 707.07(a).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 703-305-7035. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464 The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

John Ruggles
Examiner
Art Unit 1756

EXAMINER
TECHNOLOGY CENTER 1700